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THE BENEFITS OF RIPARIAN DEVELOPMENT:

A Report to TGS Technology Inc. on Procedures for the Economic Evaluation of Riparian Protection Projects of the U.S. Bureau of Land Management

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Chapter 1

Introduction and Overview

1.1 Objectives

The overall purpose of this study is to document methods used to evaluate riparian improvement projects and provide examples of economic benefits of properly managed riparian areas. Specific objectives are:

1. Review the type and extent of individual benefits that have been analyzed during riparian improvement planning.

2. Review the type and extent of individual benefits that have been monitored as a result of riparian improvements.

3. Document those benefits that feasibly could be used for similar riparian area ecosystems throughout lands administered by BLM.

4. Recommend standard quantification and modeling techniques for future riparian area improvement planning and analysis.

5. Identify obstacles to greater acceptance of riparian area improvements by private cooperators and BLM staff.

1.2 Background

A riparian area is defined as an area of land directly influenced by permanent water. It has visible vegetation or physical characteristics reflective of permanent water influence. These areas are unique and among the most productive ecosystems on public lands. Properly functioning riparian systems provide valuable vegetation and water resources for a number of uses.

The objective of riparian area management in the Bureau of Land Management is to maintain, restore, or improve riparian resources to achieve healthy and productive ecological conditions for maximum long-term

benefits. BLM policy requires land use plans and site specific activity plans to recognize the importance of riparian resources and to initiate management to maintain, restore, or improve these resources.

While economic benefits of improved forage for livestock and wildlife have been accepted, other benefits have not been well documented. Multiple product benefits from riparian improvements have not been used in the analysis of activity plans. BLM realizes this circumstance cannot be corrected until there is an extensive review of riparian projects and the findings are made available for project analysis. To meet this need BLM contracted with TGS Technology Inc. in March, 1989 to perform the services necessary to accomplish the objectives identified in 1.1, above. TGS provided a consultant for the project.

1.3 Working Strategy

The plan of work for the study as developed by the consultant and the contractor's representative incorporated a review of the literature with visits to BLM field offices. The strategy was designed to make the literature search as practical as possible and to ground the field visits in as much general knowledge as was practical. The idea was to iterate between fact and theory; to combine science and management.

The appendices contain chronological details of the field visits and a summary of the bibliographic search.

1.3.1 The Concepts of Supply and Demand

The conceptual approach taken in this study is to separate the discussion of riparian benefits into a supply side and a demand side. The supply side deals with specifying the biological and physical effects of managing riparian resources, matters resource specialists are most familiar with. The demand side deals with determining how much value these biological and physical effects have to people, which, it has been said, "determines the degree to which riparian ecosystems will eventually be conserved" (Crumpacker 1985).

This separation of the supply and demand-the natural and the economic-is meant to avoid confusing the questions we should be asking. Too often resource managers dismiss the question of benefits with the cry of "how do you put a value on it?" when no one has quantified or even adequately conceptualized the effects represented by "it." When one lacks solid evidence to support a point one tends to mythologize as a way of creating uncritical acceptance of the belief that practices like riparian preservation are good things to do. The working premise of this study is riparian benefits can be demythologized by quantifying the physical and biological effects of riparian protection and by quantifying the values these effects have for people.

The level of analysis of this study is the upper watershed or headwater area. Although the focus is the riparian area, the watershed, which encompasses the riparian zone and associated uplands is the unit which must be considered in managing for any set of results in the riparian zone. The headwater area is preferred for simplicity's sake because downstream riparian zones can have extensive uplands associated with them.

1.3.2 Science and Management

To effectively quantify the effects of managing resources the resource specialist must possess the tools of a scientific discipline but must be able to shed some scientific caution and extrapolate from imperfect knowledge. This requires the attitudes of a manager and the skills of a scientist. The comparison of alternative management programs and the choice of the best ones requires explicit value judgments and/or using information on values which may be collected by social scientists. Natural resource specialists may be trained not to make value judgements but managers specify values each time they make a choice. The purpose of this study is to equip scientifically trained resource managers with better tools for making choices.

1.4 Some Findings in Brief

1. BLM has some outstanding riparian projects which demonstrate a large potential for restoring degraded ecosystems in the western U.S.
2. The documentation of the benefits of riparian programs in BLM depends heavily on the ground level photograph which provides visual evidence of restoration. This visual evidence is used to support much of the conceptual and verbal argument for riparian protection.
3. BLM is beginning to collect some observations which will more nearly provide quantitative estimates of riparian effects.
4. The literature on riparian and watershed management indicates substantial progress in understanding and modeling natural and physical processes but contains no completely acceptable studies evaluating benefits.
5. The models for benefit cost analysis, and BLM's Manual H-1740-1, require quantified estimates of benefits for investment analysis but these will not be available until there is more systematic effort to estimate supply side effects and demand side values.
6. BLM has the opportunity through integrated rangeland management to include more fully described and evaluated soil, water and wildlife activities in its renewable resource improvement and treatment plans.

Chapter 2

Defining Benefits

2.1 Introduction

In this discussion riparian benefits exist only if they have a demand side and a supply side. The presence of a demand side means there can be found somewhere in society an expression of willingness to pay for the benefit. The presence of a supply side means the riparian or watershed system in question is producing the goods or services which are the object of the expressed willingness to pay.

It must be obvious that riparian project benefits are the desirable end results of riparian projects. However, it is necessary to establish some rules at the beginning of this discussion so that later confusion may be avoided.

2.2 Rules for Defining Benefits

Rule Number 1. The beneficiaries of riparian projects are people. It is common in resource planning discussions to talk of projects as benefiting wildlife or water quality or health of the riparian system but this is shorthand terminology which may be useful in discussions among resource specialists but may lead public land management plans and actions astray. The Public Rangelands Improvement Act (PRIA) helps to clarify the purpose of public land management with the finding that

> vast segments of the public rangelands are producing less than their potential for livestock, wildlife habitat, recreation, forage, water and soil conservation benefits and for that reason are in unsatisfactory condition (P. L. 95-514).

The major clarification one might make in this statement would be to place the production of vegetation at the head of the list because, given the limitation of soil and climate, manipulation of vegetation is the key to livestock, wildlife, water and soil conservation benefits. Congress defines these outputs or products as benefits because they possess social value. (Congress does not generate social values but rather responds to them.) Riparian projects produce the goods and services mentioned in this statement from PRIA; and these goods and services comprise most of the benefits of riparian projects. This may seem obvious but nothing is obvious in resource economics. Thus we appeal to another rule to explain why we must resort to statements of social value to define benefits.

Rule Number 2. Benefits are based on social values, therefore, when benefits exceed costs, total social welfare increases. If soil conservation practiced on a BLM watershed produces values to some persons and these values exceed the costs imposed on those persons, their welfare has improved. If the total improvement in welfare of all beneficiaries exceeds the total costs of the practice, then total social welfare has improved.

Rule Number 3. Social values, the basis of benefits, are constantly changing. In this discussion of social values the concept of intrinsic value has no meaning because the word "intrinsic" refers to an unchanging characteristic of an object. In the realm of social values change occurs constantly because peoples' attitudes and desires change. A natural resource cannot have intrinsic social value, although it may have intrinsic chemical, physical and biological properties.

It follows from this that social values are all that matters when it comes to defining the benefits of BLM riparian projects. It does not follow that there is nothing to be said for biotic, scientific, philosophical values etc. Some social values can be based on the biotic, scientific or philosophical appreciation of natural objects. For instance, the biotic, scientific and philosophical values of endangered species are recognized in law and the actions of BLM are guided accordingly.

As a public agency, BLM is charged with maintaining the productivity of the public lands and "productivity" includes values to persons who may only be interested in an improved condition of the public rangelands because it pleases them to know public rangelands are being protected for subsequent generations or certain biotic or scientific properties are being protected. This is existence value.

Rule Number 4. All benefits accrue to people who are private individuals. Frequently we talk about benefits to the public as though the public were something other than a collection of private individuals with different wants and purposes. A true public benefit, like defending the nation, would accrue to each anonymous individual in society. In evaluating benefits of riparian projects the important distinction is not between public benefits and private benefits but between different kinds of benefits and accruing in different quantities to various individual

beneficiaries. It may be that the permittees on allotments are more easily identified by name than the deer hunters who use the same allotments but the hunters are not more public than the livestockmen, only more anonymous. Deer hunters are similar to ranchers in having a willingness to pay for a product of BLM lands. BLM may have its "publics" but they are individuals receiving benefits which can be measured with some certainty, which brings up the next rule.

Rule Number 5. All benefits have monetary values. In this discussion of benefits of public land management we will not exclude some benefits because, like hunting and fishing, they are not commodities traded in markets, or like existence values they accrue to many people who care about the public lands even if they never intend to visit them or make any claim on them save bequeathing them to the next generation. The monetary value of a benefit is the sum of individual willingness to pay that exists for the benefit. An individual's willingness to pay is a measure of the benefit to the individual and may be indicated in the market value of grazing or it may be indicated by hunters' willingness to travel substantial distances to hunt. Willingness to pay is also measured in surveys, including surveys of people's willingness to pay for existence value. Any benefit can have a willingness to pay value which is expressed as a price per unit ($/aum, $/hunter day). A corollary proposition: if there is zero or negative willingness to pay, the demand for a benefit does not exist.

Rule Number 6. It may not be feasible to estimate the monetary value of all benefits. It may not be feasible to conduct the studies necessary for placing monetary values on all kinds of benefits. Protecting threatened and endangered species is an example of a demand placed on BLM resource management which has a monetary value which is usually not feasible to estimate by the usual means because of the great expense of doing so. The kinds of values which can feasibly be monetized prior to a decision are grazing, user days of recreation and soil and water benefits. It is customary to speak of the monetized benefits as "tangible" values. "Intangible" values are those benefits which are not monetized. Tangible values can be compared to the dollar costs of a treatment as in benefit cost analysis. Intangible values become "tangible" the moment BLM managers commit dollars to them.

BLM resource specialists have access to the price of forage for livestock and the prices of recreation days for a range of consumptive and nonconsumptive types of recreation which may increase as a result of riparian management. BLM, nor any land management agency, has yet to develop satisfactory prices for, or policies for the estimation of prices, for the flood prevention, sediment retention, water quantity and water quality benefits of riparian and uplands restoration, or for existence value.

2.3 Benefits Have a Supply Side

The necessary and sufficient conditions for the existence of riparian benefits are a positive willingness to pay on the demand side and a riparian system capable of supplying the good or service demanded. Riparian vegetation produces food for herbivores and resting and nesting places for wildlife. Riparian vegetation produces a source of food and enrichment for life in the stream, stabilizes banks, changes stream geometry and water quality, and provides shade which lowers stream temperatures. These processes determine the extent to which riparian benefits are produced or supplied.

BLM riparian projects can supply a variety of potential benefits, but the exact set of benefits supplied depends on the physical and biological processes operating in particular cases. Generally, the benefits that occur in identifiable increments include:

1. More esthetically pleasing environments for general recreation.
2. Enhanced opportunities for enjoyment of archeology and history.
3. More fish and wildlife to watch or pursue.
4. More forage for certain grazing seasons or livestock uses.
5. Improved surface or subsurface water supplies for agricultural, livestock and municipal use.
6. Reduced damages from flooding and siltation.
7. Improvement in certain water quality parameters.
8. Improved habitat and populations of T&E species.
9. Existence of productive, interconnected upland and riparian systems.

Chapter 3

The General Existence of Benefits

3.1 Introduction

The preceding chapter dealt with the logical conditions for the existence of riparian benefits. This chapter deals with the empirical existence of benefits in BLM riparian and associated upland projects. We need logical and empirical rules to follow if we are to consistently and accurately evaluate benefits for project investment analysis. Defining the information needed for benefits analysis also defines some of the inventory and monitoring information to be collected before and after management practices are installed. Also, if the inventory of potential benefits on a project establishes the occurrence of certain benefits as highly unlikely, then it would be wasteful to do more than cursory monitoring of the natural processes and/or human behavior that would uniquely produce those benefits. For example, if the inventory of stream geology and geomorphology established a very low probability that bank storage and release of groundwater could be re-established in a stream, this would be a low priority issue for further monitoring and measurement if conditions are not bound to change. The absence of any perceptible demand for increased instream flows would be less cause for not monitoring this condition because demands can change much more readily than the natural conditions of supply.

This chapter continues the discussion of both sides of the benefits equation: the demand side and the supply side.

3.2 The Demand for Riparian Benefits

3.2.1 Demands which may be ubiquitous

The first category of demands to be examined are those which may be found throughout the West.

3.2.1 Recreation

It is difficult to think of recreational activities involving the public lands that are unique only to certain populations or localities. Interest in history, archeology and rockhounding is fairly widespread. ORV's are everywhere, although dune buggies may replace snowmobiles in some climates. There is interest in some kind of hunting, fishing and wildlife viewing everywhere. Generally access to the public domain is free of charge. Gaining access to public lands can be a problem where private property restricts it but wildlife is usually mobile and may be migratory so it will usually have value someplace at sometime.

3.2.1.2 Grazing

In general there is a demand by livestock operators for forage. Grazing requirements may differ by climatic regime. Where winters are severe the value of winter forage may be high. Where late summer and fall dry seasons are severe the value of riparian vegetation during those seasons may be highest. Grazing fees seldom restrict the demand for forage on BLM land because they are substantially below market rates. At current grazing fees ($1.86 in 1989) the industry generally will use all the forage BLM will allow to be taken but there can be exceptions which must always be expected and evaluated. If an allotment is vacant or underused and has no prospect of being grazed to capacity, then the livestock benefits of increasing forage production on that allotment are less than the full value of the forage.

Any allowable production not taken by livestock will not necessarily increase available wildlife recreational opportunities. Whether wild herbivores increase as a result of increased available forage will depend upon whether forage is the limiting habitat factor.

3.2.1.3 The Question of Remoteness

The remoteness of areas where BLM might produce services of value to graziers or recreationists is hardly an issue. Virtually all of BLM's domain has been opened up, at least outside of Alaska. The fur trade, mining and livestock industries have accomplished this. If an exceedingly remote area has a productive riparian area, it may be used by fewer persons whose satisfaction or benefits may be higher because the use will be uncrowded, but in all likelihood there will be use.

3.2.1.4 Flood Damage Reduction

The value of reducing flood damages may be highest where downstream areas are most vulnerable to damages. Nearly any kind of downstream area will be susceptible to flood damages with the most visible damages occurring where physical capital is damaged or human lives jeopardized. If homes, barns, fences, croplands, bridges, highways, irrigation ditches and any other form of capital are in the flood path, they are candidates for damage. Floods can also damage the productivity of natural systems. Where the floodpath contains only natural systems it still is necessary to consider the existence of flood damages. Major floods can damage substrate for fish spawning and bottom organisms, rob streambanks of overhanging vegetation, degrade channel and bank geometry, and reduce the diversity of wildlife nesting, breeding and resting sites. Some of the more frequent, say annual, high flows can be beneficial to riparian systems by building up fine sediments on banks and in stream substrate and improving fish and wildlife productivity.

3.2.2 Demands which may be location dependent

The demand for reducing sediment yield nationally is large because damages from sediment are large. Sediment related flood damages may be $700 million annually while damage from sedimentation of drainage and irrigation facilities may be $200 million (Clark et al.1985). The potential exists for irrigation ditches, highway ditches, and reservoirs to be damaged by sediment yield from BLM upland and riparian systems. Sediment damages water storage facilities. Crowder (1987) found annual cost per acre foot of storage lost in the Mountain states and the Northern Great Plains reservoirs to be $500.

As in the case of flood damages, if there are no works of man to be damaged by sediment deposition, there is still a possibility that the productivity of stream fisheries can be damaged by sediment deposition. But demand for sediment reduction is more likely to vary by drainage basin. Variation among drainage basins is portrayed in figure 1 showing the extent of nonpoint suspended solids as pollutants. Certain Southwestern and Great Basin drainage basins are shown as not affected.

Fine sediments or suspended solids create turbidity in water which can increase the costs of municipal and industrial water treatment, reduce the productivity of aquatic systems and damage hydroelectric generating equipment. In the event any of these uses occur below BLM watersheds, a demand for the reduction of suspended solids can occur.

3.2.2.1 Dissolved Solids and Salinity Control

Salinity control is occurring at high costs in the Colorado River Basin.

Estimates of damages from salt in the Lower Colorado Basin run as high as $447,700 per additional mg/l and removal costs in the upper basin range from $30 to $82/ton (Lowry et al.1989). Walsh (1977) estimates a willingness to pay of $3,206 per mile of stream to remove heavy metals from the South Platte river system to improve recreation alone. In one case in Idaho, heavy metals leached from an old mine site are making a small stream toxic; in another instance heavy metals from abandoned smelter wastes are creating a potential for pollution in waters used for recreation. In such cases one can expect to find a willingness to pay to correct the pollution. As suggested by figure 1, demand for dissolved solids control may not exist generally in all Great Basin and Northwest drainage basins but local problems can exist anywhere mining and agriculture have occurred.

3.2.2.2 Other Water Quality Parameters

Low temperatures and suitable levels of dissolved oxygen are necessary for high productivity of trout streams. Management of other water quality parameters may be a source of benefits as well.

3.2.2.3 Quantity of Water

The demand for extending the duration of flow in riparian systems is likely to exist from livestock operations for stock water, fishermen for instream flow and irrigators for flow to their headgates but the kinds of demand and the values will vary from case to case.

The value of additional instream flows can be large enough to exceed the value for consumptive agricultural water uses (Walsh et al.1980). Loomis(1987) in a survey of instream flow benefits studies in Colorado, New Mexico, and Utah, finds most values lie between $14 and $27 per acre foot per year. A variety of studies indicate a range of values for an additional acre-foot in irrigation and industrial uses from a low end of $2.21 to $26.75 in irrigation and up to $600 per acre foot in industrial cooling towers (Lowry et al.1989). Value will depend upon whether water is scarce or plentiful and the value of the water in use.

3.2.3 Existence Value

The endangered species act and similar demands for protection of areas of critical environmental concern voiced in FLPMA demonstrate the power of existence value. The riparian protection movement can safely be said to contain a large component of existence value, based in part on perceived scarcity. Hays (1984) notes Americans have changed their attitudes toward formerly useless western drylands and now value them as natural lands, which he interprets as part of the growth and elaboration of the American

standard of living beyond necessities and conveniences to esthetics and amenities.

3.3 The Supply Side

3.3.0.1 Introduction

The supply side deals with the ecological and physical processes of riparian and upland systems under particular management regimes. The ecological and physical production processes determine the kinds and quantities of services provided by riparian and upland systems. The process of production in natural systems typically consists of numerous complex relationships. The education and experience of resource specialists is concerned with knowledge of these processes and the possibilities of managing them for productive ends. One of the issues in management concerns the degree to which different productive ends compete with one another.

The production possibilities can be limited by external circumstances. For instance, riparian protection will not produce positive results if the upland is in degraded condition (Van Haveren and Jackson 1986). The first step in providing a more stable riparian area is improving watershed condition (DeBano and Schmidt 1989).

One may know the maximum quantities of different combinations of products which can be produced from a resource system but one cannot know what to supply from the system without knowing the demand for the different products which can be supplied. In this section we are concerned only with surveying the literature which deals with the production of goods and services from riparian and upland systems.

3.3.1 Grazing

Livestock grazing is a compatible use in riparian areas if the grazing management considers and adapts to certain basic riparian area ecological relationships (Kinch 1989:2). It is almost a given that with management of grazing a degraded riparian area will revegetate naturally and habitat conditions for fish and wildlife will improve. In southeastern Montana certain grazing restrictions must be observed under the general rule that the less grazing the better for vegetative recovery and a caveat that some riparian systems may be too sensitive to support any livestock grazing (Myers 1989). In the Pacific Northwest the potential for increased beef production during late summer and fall on riparian meadows compared to adjacent upslope areas is dependent on the community structure of both areas (Vavra 1984). In reviewing the literature Skovlin (1984) concluded that rest for four of five years followed by late season controlled use can be 75 percent as effective as corridor fencing over a ten year period. Rest-rotation grazing would take 15 or more years to effect 50 percent

recovery unless aggressive management were practiced on animal distribution. One investigation found grazing streambanks where stream discharge and bank moisture levels were low caused no changes in streambank stability or channel shape, and suggests this may obviate the necessity of automatic grazing reductions or exclusion of grazing (Marlow et al.1989). Studies reported by Platts and Raleigh (1984) indicate rest-rotation grazing intensities and timing must be carefully selected to restore riparian habitats. Prescriptions for grazing riparian stream systems to promote riparian functions and recovery can be found in Kinch (1989).

Possibly the strongest competition in riparian products is between grazing and fish production. The response of fish populations to riparian restoration was studied in five cases. Two cases involving light livestock grazing produced an average increase of 184 percent in fish production after fencing (Skovlin 1984). In a comparison of grazing systems Platts (1989) suggests maximal fish production can be achieved only with no grazing at all. However, others state that fish production can be increased by grazing if canopy closure is in danger of exceeding 80 percent without grazing (Prichard 1989). Holistic resource management also makes a case for the positive effects of grazing (Kinch 1989:27).

3.3.2 Size and Biological Productivity

The delivery of beneficial services may be a function of the size of the restored riparian area. The extent of the area of recovered vegetation is critical for certain species of birds. An area of 70 ha. is too small to attract and house many pairs of species that require large areas for breeding territories. Layers of vegetation are also important; additional layers provide niches for additional species of birds (Ohmart and Anderson 1986). If managers fence stream corridors for rehabilitation they need to fence sufficient lengths to reduce offsite habitat degradation and to control limiting factors inside the exclosures (Platts and Nelson 1985). Size of the riparian pasture also affects grazing management. On small allotments exclusion may be necessary for riparian recovery. When the riparian area is included in pasture "some authors recommend that as much of a stream be included in a pasture as possible and that the stream not be used as fenced pasture boundaries (Kinch 1989:14).

3.3.3 Threatened and Endangered Species

A riparian system may deliver protection for threatened and endangered wildlife species. There are 64 wildlife species presently listed as endangered and 47 more species being considered for listing which are dependent on riparian habitats (Ohmart and Anderson 1986). These authors observe that if riparian ecosystems were totally lost or continued to be reduced to vestiges of their natural state, 60 to 80 percent of our native wild animal species could be lost in the western U.S.

3.3.4 Channel Morphology

A degraded condition in which the stream is isolated from its riparian zone by channel downcutting or channelization seriously impairs the productivity of the riparian zone. As a riparian zone revegetates channels typically aggrade, elevating channel and building banks. Water tables rise and ultimately water may reach the root zone on former terraces and floodplains. If this happens vegetation may change to riparian species. In one case 50 years without grazing resulted in a 94 percent decrease in channel area as a result of growth of channel bank vegetation. The principle non-fluvial effects of streamside vegetation are anchoring of channel banks and trapping of sediment (Clifton 1989).

In a comparison of a rested section with two grazed sections on either end the rested section with improved stream banks was able to contain the high flows and showed only slight increase in channel width. Floodplain vegetation and soils were altered dramatically in the grazed sections following storm events whereas the rested section showed little evidence of vegetation change or newly eroded sediments (Ohmart and Anderson 1986).

3.3.5 Soil and Water Effects

Skovlin (1984:1047) reviews relationships between grazing and infiltration, runoff, sediment and water quality. The Society for Range Management publication on rangeland hydrology (Branson et al.1981) supports Skovlin in demonstrating a rich scientific literature on rainfall, runoff, erosion, sediment yield and water quality. The successful modeling of a number of rangeland hydrologic processes reflects an ability to project outputs from given conditions. It is apparent that a sizable body of knowledge exists on the soil and water effects of rangeland management. In the sections which follow we are looking for evidence of the ability to project quantitative effects of soil and water management.

3.3.6 Flooding and Sedimentation

Unregulated and excessive use of the public domain has long been associated with abnormally high sediment yields, flooding and channel cutting. Four mud-rock floods issued from Parrish watershed in Davis county Utah in the summer of 1930 causing more than one third million dollars in property damage. Sediment yield equalled 153 acre feet per square mile from the unprotected watershed while a nearby, undamaged watershed produced .0025 acre feet of sediment per square mile (Copeland 1963).

Thirteen watersheds in the Blue Mountains of Oregon were studied from 1979 to 1984 for the effects of vegetation type and grazing intensity on storm runoff in 485 storms. Vegetation type and grazing intensity had no statistically significant effect on storm runoff volume and peak flow

(Higgins et al.1989). One of the authors has indicated grazing intensity may have affected the ratios of mean to extreme flow and the peakiness of runoff and recommends future studies use completely fenced watersheds and incorporate grazing history into study design (Tiedemann 1989).
Forests and other dense upland vegetation reduce flood peaks, eliminate surface runoff and increase baseflow. However, denser vegetation is unlikely to effect a significant reduction in the rare flood peaks usually used in designing structural measures for downstream flood control (James and Lee 1971:502). Thus, the total effects on flood reduction are reduced by the inability of vegetation to influence rare flood events.
Vegetative condition of the riparian zone may affect flooding and sedimentation in the restored riparian zone and downstream. Vegetation influences hydraulic conductivity by contributing roughness elements and shear strength to the channel perimeter. Increased roughness increases resistance to flow and promotes sediment deposition. Elmore and Beschta (1987) believe willows, sedges and rushes hold stream and riparian zones together by maintaining bank stability, filtering and depositing sediment and resisting high flows. Burkham (1976) in a study of the effects of changes in bottomland vegetation on major floods finds vegetation with foliage reduces mean velocity seven percent and increases mean depth and roughness each by 11 percent while with no vegetation mean velocity increases by 25 percent and mean depth and roughness decrease by 15 percent and 30 percent, respectively. Riparian zones may be important traps for sediments (Lowrance et al.1986).

3.3.7 Water Quality

Although reduced sedimentation downstream from a protected watershed and riparian area may be desirable, Ribaudo and Young (1989) found difficulty in a national model of pollutant loadings in detecting lower ambient concentrations of suspended solids, N and P below threshold levels that could be traced to reduction in soil erosion but they concluded the model could miss local effects.

Investigators have found positive offsite recreational benefits in reduced sediment yields by concentrating efforts in relatively small problem watersheds of the types which may be common on public lands (Young and Magleby 1986). Figure 1 demonstrates that nutrients, dissolved and suspended solids may not be a general problem in western watersheds. However, fecal coliform, salt, heavy metals and toxics can be local problems.

3.3.8 Bank Storage and Dry Season Streamflow

In reviewing the process of riparian zone revegetation Elmore and Beschta (1987) conclude that if more water is stored in the banks during wet seasons and released during dry seasons, the stream may flow during the driest of summers. Lowry et al.(1989) found 400 to 600 acre feet of bank

storage in a restored stream in Wyoming, most of which was attributed to the restoration.

3.3.9 Cultural Resources

Cultural resources may be significant parts of riparian areas. Objects significant in American history, architecture, archeology and culture often occur within riparian systems (Mikkelsen and White 1984). In Bonita Creek, Arizona traces of historic and prehistoric desert settlement are found and can be preserved by appropriate management of the riparian zone.

3.3.10 Scarcity and Existence Value

Rarity or scarcity in the supply of an object or service can be a source of existence value. Generally, the more scarce an object becomes the higher the price it will fetch in markets and the more it is prized by its possessors. Applying this principle to nonmarketed goods, we would say the rarer an ecosystem type becomes, the more highly people value the preservation of the existing remnants for themselves and their heirs.

Scarcity may increase the existence value of certain western riparian communities. Ohmart and Anderson (1986) note that 90 to 95 percent of the cottonwood-willow riparian ecosystems of the Great Plains and lower Rocky Mountain foothills have been lost since the time of European settlement. Possibly 80 percent of the remaining riparian ecosystems are in unsatisfactory condition and are dominated by human activity.

Chapter 4

Techniques for Economic Analysis

4.1 Introduction

The preceding chapters have established certain conditions to be met in the economic analysis of riparian benefits.

1. The techniques must analyze both the demand side and the supply side of benefits.

2. The supply side analysis must produce quantitative estimates of the effects of watershed and riparian management in terms of outputs of goods and services.

3. The demand side analysis must produce estimates of unit price for the goods and services produced and evidence the quantities produced are wanted. Unit price can be based on market data or on extramarket data. Outputs which cannot be successfully priced can be treated in the intangible or non-quantitative analysis which must necessarily accompany every resource management decision.

4.2 BLM's Current Economic Procedures

To establish background we will review BLM's current procedures for economic analysis. BLM's procedures are the result of 25 years of evolution in methods for investment analysis of range improvements and watershed programs. Basic instructions for current procedures were issued in 1982 as a "Final Rangeland Improvement Policy" (IM 83-27) and made BLM managers accountable for "assuring that these procedures for evaluating, ranking and scheduling improvements are followed." The procedures required the Sage Ram computer program be used to provide "a consistent basis for cost/benefit and related analysis and to generate information that must be kept in allotment files." In 1987 BLM issued an updated version of its investment analysis procedures.

4.2.1 H-1740-1

The BLM procedures for economic analysis are outlined in Manual Handbook H-1740-1 (BLM 1987). This publication, which is entitled Renewable Resource Improvement and Treatment Guidelines and Procedures, specifies the economic analysis procedures to be used in BLM range, soil and water, wild horse and burro, forestry and wildlife investments. There are detailed procedures for range and wildlife investments and more generalized procedures for the other renewable resource programs. The distinguishing features of the wild horse and burro program are the legislative requirement for protection and the lack of any prices which have been estimated for the products of the program. Because the program is based on an absolute requirement for protection, the procedures for economic analysis of the horse and burro program emphasize cost minimization in achievement of specific project objectives.

4.2.2 Soil and Water Program Needs

The soil and water program is similar to the horse and burro program in the lack of estimated prices which can readily be assigned to the results of projects but differs in the lack of an emphatic legislative mandate. Lacking such a mandate, there is a need to have specific procedures for estimating and pricing the outputs of projects. More specific guidance for soil and water projects would round out the BLM's ability to analyze fully the benefits of riparian projects. Soil and water procedures could be made compatible with the Sage Ram computer program and even linked to the program as subroutines and data bases.

4.2.3 The Project Evaluation Thought Process

The crucial part of the H-1740 manual is the framework or thought process advocated for project evaluation and planning in section I. The thought process for project evaluation emphasizes logical principles of project planning and rational project evaluation with such questions as:

- Have the management objectives been identified?
- Will the proposed project achieve the objectives?
- Have all the alternatives been considered:
  - changes in management rather than structural changes?
  - other types of activities?
- How do the costs of the alternatives compare?

- Will the expected benefits equal or exceed the costs?
- Do the costs include mitigation of adverse impacts?
- Will funds be available for project installation, maintenance and reconstruction when needed?
- What priority does the proposed project have?
- Are funds being allocated to projects that yield the highest return to on-the-ground investments?

4.2.4 Principles for Soil and Water Projects

Riparian and related upland projects are not so different from the more traditional BLM projects that their economic evaluation cannot conform to the principles enunciated for project analysis in H-1740-1. The general rules for benefit cost analysis of all projects are:

- Economic feasibility is measured by the B/C ratio. Assuming all benefits and costs are measurable, if the B/C exceeds 1.0 or some other benchmark greater than 1.0, a project meets the economic feasibility test. If, among the mutually exclusive alternatives the project has the largest B/C, it meets the efficiency test.
- Benefits and costs are to be quantified (in monetary terms) to the extent possible. Benefits (and costs) are seldom all measurable and so a B/C ratio less than 1.0 is acceptable if, on balance, the project's benefits, including benefits not monetized, outweigh its costs.
- If benefits cannot be expressed in monetary terms, economic feasibility can be indicated by the least cost test: the project must be the least costly way of achieving the objective.
- All benefits and costs "to whomsoever they accrue" are included but additional analyses may be done to consider only BLM's or private parties' benefits and costs. Private costs include those costs induced by the project.
- Economic analysis is to be based on the "with and without" principle, which is that physical and biological changes are projected to the best of ability with and without the proposed project. The differences between the two scenarios are the basis for estimating benefits.

4.2.5 Stages of Economic Analysis

Prior to reaching the project planning stage the allotment or area will have been given a rough analysis of resource potential, which is fundamentally an analysis of economic potential. This first component in watershed planning is watershed condition analysis in which a watershed's vulnerability to degradation and responsiveness to management are estimated. The equivalent first component for analysis of riparian condition is typically a stream survey and evaluation coupled with vegetation inventories and can be incorporated in the Riparian Aquatic Information Data Summary (RAIDS) (BLM 1988).

The H-1740-1 project planning procedure incorporates a two stage economic analysis. A project is any stand-alone component of a plan. Two years before a project goes into an annual workplan it is to be given a preliminary feasibility study and cost estimate. The feasibility study can include an abbreviated benefit cost test, called the prudent investor test, which employs a shortcut method for discounting annual benefits and costs in testing for a favorable benefit cost ratio. One year before becoming part of an annual workplan a range improvement project, in particular, undergoes a more complete benefit cost analysis (employing the Sage Ram computer program) and receives a priority from the Area Manager, the District Advisory Board and the District Manager. It could be a BLM requirement for soil, water, wildlife and riparian projects to receive the same treatment but in practice the projects funded from range improvement accounts and not the other renewable resource accounts are the most likely to be given this full review. A recent review of the range improvement program subactivities 8100 and 8200 has found "Bureau guidelines and standards for integrated or coordinated activity planning are inadequate..." and proposes to develop standards for integrated rangeland management plans by the end of FY 1990 (BLM 1989).

4.3 Procedures for Riparian Projects

4.3.1 Introduction

The procedures discussed in this section are extensions of the concepts and principles in the H-1740 manual and are intended to apply generally to the economic analysis of BLM watershed and riparian protection and restoration projects in allotment management plans or activity plans. To be consistent with earlier sections the supply side and demand side are addressed separately. Recommendations are presented at the end of the chapter.

4.3.2 With and Without Comparisons

The key to project analysis is being able to project and evaluate

differences with and without some project or management activity. This ability to speculate about the future combines the attitudes of a manager and the skills of a scientist. Both manager and scientist will have standards for collecting accurate and systematic data and for building models carefully and correctly but the scientist will want to avoid prediction, will be reluctant to make less than conclusive statements and is trained to be value free in his or her work. The manager must be willing to speculate when necessary, has to make projections and is required to make explicit value judgments using available information on social values, including market and extramarket prices (Cooperrider 1986a).

All BLM watershed and wildlife specialists are engaged in applying scientific knowledge to management of natural resources. Many were trained as scientists and all were educated in their technical subjects by scientists. They are expected to be scientifically rigorous in their collection of information and in the analysis of information. As managers of natural resources they are required to exceed the limits of science in making projections and recommendations, and participating in choices. Their scientific training may not have prepared them for the judgement, the willingness to extrapolate and the degree of comfort with social values required by the task. This can be an obstacle to the adoption of evaluation procedures in BLM.

4.3.3 Supply Side Analysis

Supply side analysis depends crucially upon the availability of models for projecting with and without conditions. The sets of relationships in physical and biological systems are usually too complex to be analyzed without the aid of models. A model can be conceptual, verbal, or quantitative. Cooperrider (1986b) illustrates the evolution of models from the conceptual to the quantitative. Models are aids to thought and not substitutes but without explicit models facts can be bewildering and thinking can go astray.

A quantitative model can be as simple as an equation estimating streamflow or as complex as a computerized simulation of production and utilization of rangelands. Information collected for inventory and monitoring purposes is likely to be useless for projecting with and without conditions unless there was a more or less explicit model in mind when it was collected and that model is useful for projecting and extrapolating.

4.3.4 Empirical Process Models

BLM has long experience in methods (models) for estimating forage production but estimating forage production has been a "largely subjective exercise" (Heady and Bartolome 1977:130). Boyd et al.(1986:524) note determining the amount of forage that can be used without damage is more art than science.

BLM wildlife biologists have developed a limiting factor model for projecting wildlife populations with and without changes in management. The limiting factor approach is quantitative and formal, which is consistent with a trend in modeling because it allows more precision and results can be more clearly documented (Cooperrider 1986b).

A variety of models are used to evaluate fish habitat. This investigator found the Duff and Cooper (1976) system in use in BLM field offices in the Great Basin but the biologists involved were reluctant to trust the system for projecting habitat conditions and carrying capacity under changes in management. They were hoping instead that a project currently sponsored by BLM, FS, and Nevada and Utah fish and game departments would produce a model suitable for projection of fish production in streams of the Great Basin (Evans and Price 1989). The anticipated Great Basin model may be an offshoot of the Forest Service COWFISH model which was recently evaluated on 43 stream sites in the Beaverhead National Forest and found to successfully predict rainbow and cutthroat trout numbers but to err in predicting brook trout populations (Shepard 1989). In Arizona HEP procedures were used in the Bill Williams hydrologic study by Jackson and Summers to establish instream flow targets and a New Mexico State instream flow model has been used on Burro Creek and Aravaipa Canyon. The FWS national ecology research center which developed the HEP procedure has also developed PHABSIM to simulate physical fish habitat as a function of stream flow. Milhous (1986) has proposed using PHABSIM to construct a fish habitat time series for streams using flow as the determining variable.

Soil and water specialists and aquatic biologists have a variety of methods and models available for evaluating physical features of streams (Cuplin 1986) and watershed and riparian hydrology to the extent of equations for predicting 2, 5, 10, 25, 50, and 100 year flood discharges and mean annual runoff for four Western regions (Van Haveren 1986:622). Branson et al.(1981) present a variety of complex rangeland hydrologic relationships and review the state of the art in hydrologic modeling. In their view there were a number of successful rangeland hydrologic models in 1981. BLM's situation would seem to call for reviewing and recommending models for use in field offices to estimate soil loss, sediment yield, flood discharge, annual discharge and water quality yields of watershed/riparian systems with and without changes in management.

In 1982 BLM completed participation in development of the Saval Ranch simulation model which consisted of components on vegetation, hydrology, livestock and wildlife. The outputs of the model were called "tenuous at best" but the experience led to revision of plans for hydrology research and "imminent" changes in the approach to measurement of vegetation production and livestock consumption. The principal discovery may have been of the need for "more sophisticated and formal data management schemes if model building and interdisciplinary transfer are to be successful" (AEA 1982).

Another development since 1981, a USDA computer model, Simulation of Production and Utilization of Rangelands (SPUR) integrates hydrology and climatology with range ecology. SPUR has a grazing unit and basin scale of

less than 10 square miles, will generate weather at a prescribed location and incorporates amount and intensity of grazing in estimates of soil loss and surface runoff (ARS 1983). ARS is refining a simpler program called ERHYM which will be used to project and evaluate forage conditions based on soil and water parameters (Gebhardt 1989).

BLM is developing numerous computerized information systems, all of which are candidates for linkage to models which are capable of extracting specific elements of quantitative information for direct use in project planning and quantitative evaluation. The GIS may be the prime candidate for such attention because graphic output from the system fills only part of BLM's planning needs. Nebert (1986) reports investigation of the use of GIS to supply surface water models with basin characteristics. With assumptions the effect of riparian zone changes on discharge can be simulated with definable levels of error.

Computer simulations have one thing in common: model documentation warns that the model may be incomplete or may have to be adapted to specific uses. These warnings are enough to dissuade most potential users from getting involved. One should be aware these warnings are often inserted to protect scientific reputations and may have no bearing on the potential usefulness of the model to practictioners who need better means of coping with complex natural variability. Mathematical models which depend on solutions to equations instead of simulation are also used in hydrology (and economics). A computer simulation can incorporate a number of mathematical models representing specific processes like runoff, soil loss and channel velocity.

Verification of models is important. Without verification a model is an untested hypothesis. Various techniques are used by model builders for verification. Models used in field offices for planning and evaluation should have been tested and verified by their builders but users will always need to check a model's outputs against reality and be prepared, reluctantly, to intervene if the results are unbelievable.

4.4 The Demand Side

The analytical task on the demand side is to determine the existence of demand and to estimate unit prices. Large organizations which depend heavily on benefit cost analysis or upon making a profit, hire staffs of accountants, economists and MBA's to estimate demand and unit prices. BLM has few economists and so must depend on shortcut procedures which can be used by non-economists. Existing BLM procedures for estimating the demand for resource services and procedures are discussed in this section.

4.4.1 Forage and Wildlife-oriented Recreation

In cases where forage and wildlife oriented recreation opportunities are

produced, demand is considered to be ubiquitous and infinite (all the quantity that can be produced will be used) and the Sage Ram price file provides the unit prices. The calculation of wildlife benefits begins with estimation of changes in animal populations which are transformed into changes in recreation user days using conversion factors based on hunting and fishing pressure in the state. The calculation of benefits in dollars is done by Sage Ram using the user days entered into the computer and the latest estimates of price per user day which reside in the program. Each BLM state office is responsible for maintaining the best available estimates of prices in the Sage Ram program.

4.4.2 General Recreation

General recreation is not primarily based on the presence of wildlife but is related to attractive opportunities for hiking, camping, picnicking, rockhounding, visiting cultural and historic sites or travel by ORV. Demand estimates for any product of the public lands must include information on willingness to pay and quantity which will be taken. Unit prices for general recreation are available in the Sage Ram price file compiled by each state office. Recreation specialists have procedures for estimating days of use with and without improvements.

4.4.3 Flood Damages

In the case of flood damage reduction the kinds of resources capable of being damaged from flood flows in a particular watershed and riparian system need to be established and damages estimated from flood frequency-stage curves and flood stage-damage curves. These are standard practices for the Soil Conservation Service and the Corps of Engineers and follow the WRC Principles and Guidelines and standard engineering economic and hydrologic practice as presented in James and Lee (1971). The Corps will be expert in urban flood damages and SCS will be expert in agricultural flood damages. Neither agency will have paid much attention to damages to the kinds of natural systems and rangeland enterprises affected by BLM watersheds.

Flood damages have rarely been a factor in BLM allotment planning but this may be changing as riparian programs accelerate and experience with the benefits of watershed protection accumulates. The estimation of flood damages can be burdensome as the water resource agencies practice it both in standards for hydrologic data and field assessment of damages. Because some geographic variation in flood events is to be expected, it should be possible for BLM to develop a system of curves and procedures for the physiographic and rainfall regions of the West which could be the basis for calculating flood damages with order of magnitude accuracy on the small watersheds BLM manages. It would be necessary to provide guidance on estimating the kinds of damages experienced from flooding in small western

watersheds. Generalized stage-damage curves might be an acceptable shortcut alternative to making field estimates based on actual flooding. For example, Vale District has aerial surveys of flooding in small drainages which might be generalized for the Great Basin province. In order to reduce the burden on field offices, many of whom have no hydrologist, it may be desirable to automate flood damage estimation procedures under the lead of the Service Center or to provide a team of experts to assist BLM districts as requested.

4.4.4 Sediment

Sediment damages may be associated with flood damages and with water quality but the topic is important enough to be considered separately. Sediment yield and transport may be a separate component of models of runoff and streamflow. The demand for sediment control can be broken down as follows:

- Sediment is transported to water storage reservoirs:
  - * reservoir is dredged:use cost of dredging.
  - * reservoir storage is consumed: use per acre-foot cost of construction or present value equivalent of loss of benefits. [If benefits lost are less than costs, use benefits.]
- Sediment is deposited on agricultural land: use value of lost production, if any.
- Sediment aggrades a stream channel: use loss of natural production, if any, plus increase in flood damages downstream.
- Sediment is deposited in irrigation or drainage ditches: use cost of cleaning.
- Sediment gets into raw water supplies: use increased cost of water treatment.

4.4.5 Water Quantity

The price of an increase in water quantity depends upon the value of the use to be made of the water. If the water remains in the stream, it will probably improve fish and wildlife-based and general recreational values; the benefits can be reflected in the fish, wildlife and recreational analysis. If it is used for agricultural stock watering, irrigation, domestic or industrial purposes, then its price can be estimated in one of two ways.

1. The price of an alternative supply: If the user is paying for an

alternative supply of water which is replaced, or is willing to pay for an alternative supply, the costs of which can be estimated, then the value of the additional quantity provided is the cost of that alternative supply.

2. The value of additional production: if the additional supply creates additional production, then the additional net value of the production to the producer is the willingness to pay for the water. (As long as small quantities are involved, the social costs of surplus agricultural production can be ignored.)

4.4.6 Water Quality

Degraded water quality may interfere with the productivity of aquatic systems and damages will be reflected in loss of recreational benefits. Excessive dissolved solids may reduce the value of water for irrigation, domestic and industrial uses. There are several ways of performing an economic evaluation of water quality for agricultural, domestic and industrial uses.

1. The cost of treatment method: find out how much the user is paying to remove the polluting substance or to switch to an alternative (presumably more expensive) source of water. The benefit is the savings in costs of treatment or costs of alternative supplies.
2. The loss of output method: If the user chooses to forgo production or use, determine the net value of the use or production forgone.
3. The water quality requirement method: if BLM is required by law to maintain runoff to a certain standard of quality, then the economic problem becomes one of meeting the standard at minimum cost, the benefits of exceeding the standard are zero and the benefits of reaching the standard are infinite; in either event the benefits are not useful quantities.

4.5 Existence Value

As matters currently stand in BLM project analysis, existence value (and bequest value) can only be treated in the discussion of the intangibles. As mentioned in the preceding chapter, evidence of the general importance of existence value is contained in BLM's legislative mandates and reflected in changing attitudes toward the public domain. From this we know existence value cannot be dismissed as a factor in riparian and watershed protection projects but these general mandates do not tell us how much weight it should receive in particular cases. The potential significance

of existence (and bequest) values is indicated by a study of the economic benefits of proposed wild and scenic rivers in Colorado in which the authors conclude:

> In the absence of information on the willingness to pay for preservation values, too few rivers would be protected in states like Colorado, where future reservoirs, water diversions, and related development may irreversibly damage natural rivers. Thus it is proposed that project evaluation by state and federal water agencies consider the preservation value of rivers (Walsh et al.1984).

4.6 Models for Benefit Cost Analysis

BLM has computerized the economic evaluation of projects. The Sage Ram program has been available on the Denver mainframe computer since 1982 but is not used in all of the BLM field offices. A personal computer version of Sage Ram is being released for agencywide use. Sage Ram is designed to accommodate economic evaluation of all renewable resource treatments, but it is a stand-alone program requiring all data on project inputs and outputs, except some unit prices, to be generated independently and entered into the program. The possibilities for linking an economic evaluation program like Sage Ram with models which project the outputs of natural systems under management need to be investigated. Project evaluation in BLM is not a continuous process because of the need to handfeed the Sage Ram computer program. The stand-alone nature of Sage Ram is an obstacle to its use. In particular, its use as a tool in refining project designs through testing and iteration is discouraged by the need to switch modes to get into Sage Ram.

There are alternatives to Sage Ram. The Idaho State Office has adopted a Forest Service program for economic evaluation of BLM timber sales and many spreadsheet programs lend themselves to benefit cost analysis but Sage Ram is the one program developed for BLM range improvement and related projects. The job documentation reports (JDR) required for reporting on range improvement projects contained a rudimentary economic analysis, which could be expanded and automated if the JDRs were to be retained and automated. The Roswell (New Mexico) district office is experimenting with an alternative to Sage Ram which develops the costs and forage benefits of range improvements (based on before and after comparisons) and then multiplies benefits by a factor ranging from 11 to 20 which combines the discounting factor with allowance for benefits to other resource uses. (For example, a factor of 11 would equal the present value of grazing benefits at an interest rate of 8.97 percent and zero benefits to other resources per dollar of range benefits while a factor of 20 would imply $.82 in other resource benefits on the dollar, all discounted at 8.97 percent.) The Roswell alternative is not consistent with the practice of integrated rangeland management planning but it could be modified to give explicit consideration to benefits and costs of other resource uses.

4.6.1 Integrated Analysis

The Idaho State Office of BLM is experimenting with an expert system which combines knowledge of stream productivity with stream type and condition so an operator can determine trout productivity and the limiting factors for a trout stream by interacting with the program (Gebhardt and Vinson 1989). An expert system is a computer program that uses knowledge and inference procedures to solve problems that are difficult enough to require significant human expertise for their solution (Rauscher 1987). The declared purpose of the Gebhardt-Vinson system is to capture for continued application the expertise of senior scientists who are moving on in their careers (Gebhardt et al.1989). The Gebhardt system is knowledge based.

Expert or diagnostic models have a potential role in BLM because they can help the resource specialists master a large variety of procedures, techniques and thinking processes. Work is underway to install an expert system on the front end of SPUR to lead the user into the model as painlessly as possible, avoiding mistakes and increasing the usefulness of the process. The process of project evaluation is ideally suited to linkage with an expert system incorporating the project evaluation thought process, models for projecting with and without conditions and economic procedures for investment analysis. Such an expert system could be on the front end of Sage Ram, shortening the sometimes painful process of mastering procedures and models from written instructions and by trial and error and reducing the time required to relearn Sage Ram when it is used infrequently.

The procedures for economic evaluation are a problem-solving thought process requiring much training and experience for correct application. It is easy for the non-expert to make mistakes in logic and estimation which invalidate the results (Smith et al. 1987). An expert system is one alternative for minimizing such errors but would need to be complemented with development of procedures for quantification. Another alternative for BLM would be to create a team of soil and water experts whose mission would be to prepare and evaluate watershed plans. One would need to compare costs and effectiveness in making a choice between alternatives.

4.7 An Economic Interpretation of Current Soil, Water and Riparian Evaluation Procedures

Range managers, foresters, biologists and hydrologists are inclined to invent evaluation systems which perform a kind of economic evaluation by using technical concepts. Three procedures encountered in this study which do this are watershed condition analysis, the Duff-Cooper stream rating system and the Desired Plant Community concept. All procedures have been developed to help resource specialists deal with the problems of projecting response to treatments, in essence to make projections of with and without conditions.

4.7.0.1 Watershed condition analysis

Watershed condition analysis uses the concepts of vulnerability and responsiveness to assign watersheds to one of four ratings. Dynamics are introduced by allowing a watershed to move from one class to another through time. The method can be used to apply a sort of triage system to watersheds, identifying those which are best left alone, those which need maintenance and those which will respond to investment. Used in this way the method is a screening tool for selecting watersheds for further analysis.

The concepts of responsiveness and vulnerability are related to the idea of with and without analysis. Vulnerability captures the projected condition of a watershed through time without treatment. The without treatment condition can be improving or stable (not vulnerable) or degrading (vulnerable). With treatment a watershed can respond to varying degrees or not respond. Comparing the degree of response with the untreated condition gives one the with and without comparison: the difference in with and without condition through time describes the gains from treatment which can be evaluated with benefit cost analysis providing a willingness to pay value can be determined for improving a condition.

4.7.0.2 The Duff-Cooper stream rating system

The Duff-Cooper stream rating system places a stream in good, fair, or poor condition depending upon its average score on five rating factors. The rating factors are in terms of percentages but conversion of average percentages to a verbal scale of poor, fair, good produces a qualitative, non-quantitative evaluation. Use of the Duff-Cooper system raises two questions. Is the averaging model superior to the limiting factor (or another) model? Can the quantitative evaluation be preserved by calibrating the percentage scores to known productivities? One field office had related fish poundage to the verbal classes of the method with difficulty. Field offices need a system that from the evaluation stage through the project planning stage will rate streams by the pounds of fish they produce.

4.7.0.3 Desired Plant Community

The desired plant community is identified through ecological site inventory methods which establish current range condition. The DPC concept would select a seral plant community type and make it the goal for management of a particular allotment or area. Used in this way, the DPC would become a requirement or standard whose adoption would obviate the need to perform any analysis of its feasibility as an objective.

4.7.0.4 No Substitute for Economic Analysis

Before attempting to substitute technical concepts for economic analysis we should ponder the words of Thadis W. Box,

> Economics is applicable to all choosing situations, whether or not there are market prices for any of the outputs or any of the inputs. There is indeed no way that any resource manager can avoid economics. He chooses one method of management over others, or one mix of outputs over others, or one mix of inputs over others. He may deny that he is practicing economic analysis but in fact he is. His real choices are between good economics and bad economics, between the best available data and none or poorer data. He does not in the least reduce his dependence on economics by choosing bad theory and bad data (Box 1985).

All this is not to deny the place these technical procedures have in classifying and screening resources by condition. It is when they become the sole basis for management decisions that they exceed their limits.

4.8 Conceptual, Verbal, or Quantitative?

In tackling problems of choice people have always found it advantageous to think about the consequences of alternative policies rather than to choose among them by flipping coins or drawing straws. The beginning and end of the process of project evaluation are likely to be conceptual and verbal but as the process moves from beginning to end systematic thought, careful, quantitative analysis and carefully specified models, rather than conjecture, will have altered and narrowed the conceptual and verbal analysis that initially was used to identify the problem and ultimately will be used in making choices.

Much of the discussion and writing on riparian and watershed problems has been conceptual. An example is the observation by Peterson et al.(1987) on the emerging global similarities in stream management and the "holistic ecosystem approach to the riparian zone as the buffer between stream and watershed." The conceptual, non verbal plays a prominent role in the documentation of improvement in riparian conditions. In many BLM offices photographs taken from ground stations document progress in revegetation and other changes in riparian areas. These photographs are visual evidence of the healing taking place in these ecosystems as evaluated by standards derived from an undisturbed state of nature. Such visual evidence can be supported by time series observations from cover transects, stream surveys, measurement of streamflow, groundwater levels and other parameters which should be initiated before improvements have commenced. Photographs may replace words but they are not measurement or quantification.

Leonard (1988), in a study of procedures used in the Forest Service to resolve riparian protection problems, finds professional judgement and

discussion with the permittees has assumed more importance while the historical approach of relying on range data and analysis and only a little discussion with permittees is declining. It may be that useful quantitative analysis has not caught up with the need to make choices in management of riparian areas, or perhaps Leonard has identified a trend. If this is a trend, then it runs counter to the belief developed in a generation of systems analysts that it is better quantitative analysis which holds the promise of greater efficiency in government decisionmaking (McKean 1958). BLM may be in the opposite trend with increasing emphasis on monitoring and inventory information to supplement traditional discussion with permittees in the process of making allotment management decisions.

Chapter 5

Conclusions and Recommendations

5.1 The Opportunities

BLM can take a number of actions to improve its ability to quantify and evaluate in economic terms the benefits of its riparian and watershed projects.

BLM is moving toward greater emphasis on including a range of other resource activities in traditional range planning and management. BLM Manual 1619 accommodates activity plan coordination when "program priorities result in several activities simultaneously initiating or continuing activity plans covering a common geographical area" (BLM 1986). Sage Ram facilitates coordinated investment analysis. Project ranking, which involves choices among competing combinations of activities, strikes at the heart of coordination.

If, in the process of ranking projects, managers have incentives to request information and evaluation from each of the resource specialists, then each will need tools to enable them to participate in project evaluation. Three general conditions would enhance BLM's ability to analyze fully the benefits of its resource improvements and treatments, not the least of which are its riparian projects.

1. Stronger incentives for managers to use investment analysis in rangeland management.
2. More specific procedures, guidance and training for projecting and pricing the outputs of soil and water improvements.
3. More training for biologists and range conservationists in their evaluation procedures.

If incentives, procedures, and training do not fill the need, then the limiting factor may be manpower and BLM will need to examine the adequacy of its staffing of Biologists, Soil Scientists, and Hydrologists.

BLM could take some specific actions on the supply side and on the demand side to improve its ability to fully evaluate the benefits of its resource improvements and treatments.

5.2 Improving Analysis of the Supply Side

1. Review models in current use in BLM and other agencies and encourage and facilitate the use of more quantitative-but cost effective-models for evaluating current condition and projecting changes in the upland and riparian systems of watersheds.

2. Investigate the feasibility of integrating physical and biological models with expert systems to make expert knowledge and experience more widely available for projecting and evaluating the performance of riparian and upland systems and to enhance the ability of field offices to use complex models to perform project evaluation.

5.3 Improving Analysis of the Demand Side

1. Using state-of-the-art and reviewing other agencies' practices, develop cost effective procedures and guidance, with minimal burden on field offices, to instruct or assist each state office in estimating the economic values of:

    - flood damage and sedimentation benefits of upland and riparian restoration.

    - water in consumptive uses and instream flows.

2. Do a study of the preservation or existence values of riparian and upland restoration projects with the objective of summarizing quantitative evidence from applicable studies and formulating principles and procedures for treating existence values in project evaluation.

3. Demonstrate and test the integration of demand analysis with supply side analysis in a model watershed plan.

4. Emphasize the importance of more complete and reliable information on the benefits of resource improvements and treatments for consistent integrated planning and priority ranking in the guidance being prepared in FY 90 to implement findings of the Internal Control Review.

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Appendix B

A Demonstration of Procedures

Burley District, Idaho has been asked for an analysis of the costs and benefits of its riparian demonstration projects. It responds with an analysis of costs of three projects and the grazing and wildlife benefits of the three projects combined.

Project costs are distributed over 11 years from 1979 to 1990. Table 1 lists the kinds of expenditures made by the District by year from 1983 to 1990. The 1979 expenditure of $2,000 is compounded at 8 percent rate of interest to get its equivalent value in 1983. Future costs are discounted to a 1983 present value at 8 percent. Maintenance costs of $300 per year, mainly to repair water gaps damaged by floods, are included for the 20 years period of analysis, 1983-2002 and discounted to 1983. The total present value of costs is $55,314.

Table 2 shows the list of items for which benefits are estimated. They are the standard categories for which the Idaho price file gives unit prices. Project benefits are expected to begin showing up in 1989 after the bulk of the expenditures have been made. The Burley office estimates 2 to 10 years are required for various benefits to reach their full value. The benefits without the project are expected to remain constant. Benefits with the project increase in constant increments with 2 years required for grazing to reach its full value and 10 years required for dispersed recreation and wildlife viewing to reach their full values.

The present value of benefits and costs includes 20 years, 1983 to 2002, inclusive because most project investments have a life of 15 to 20 years and information is not available on frequency of replacement. Table 3 summarizes the benefits and costs.

Table 3. Burley Riparian Project Summary

Present value of project costs		$55,314
Present value of benefits		
with project	$84,836	
without project	36,465	
Benefits attributed to project		48,371
Benefit/cost ratio		0.87
Net benefits		-6,943

The project benefit/cost ratio is 0.87 (net benefits are negative). It is not likely the project net benefits would improve if the analysis were extended to 50 years, which is the SageRam period of analysis, because many of the project costs would have to be repeated once or twice in that period. A better possibility concerns benefits (and costs) which may have been left out of the analysis.[1] Burley has not estimated any benefits for water quality, flood control, sediment retention, weed control, water storage, etc. because they "are too esoteric and variable to deal with comfortably."[2]

Shoshone District has estimated the costs and benefits of a riparian demonstration project on Thorn Creek. They were not as specific as Burley District in describing grazing and recreational benefits but they do discuss other kinds of benefits.

- Water released as groundwater is expected to flow through well vegetated water courses into Thorn Reservoir where it will lower average water temperature in the lake at mid depth by five degrees by 1994.

- Water quality will improve from reducing the amount of time livestock spend along the stream. The benefits will come from decreased turbidity and decreased coliform bacterial contamination in the stream but no water quality baseline information exists and no monitoring of water quality will take place.

- Average water yield of Thorn Creek is expected to improve by 10

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[1] Burley district did not include ranchers costs. We know ranchers will be responsible for most of the project maintenance and may have installed some of the improvements.

[2] Memorandum from Burley District Manager to State Director, received May 26, 1989.

percent between 1989 and 1994 because ground water recharge will increase and this will increase dry season stream flows. (If total yield does not increase, at least there will be an increase of 10 percent in flows during the dry season to benefit recreational use.) Ground water levels will be monitored.

How do we treat the information on water resource benefits? There are two choices: we can attempt to quantify or we can deal with it in the conceptual discussion that must precede project approval. To quantify we will want more information. We will need to know how the decrease in water temperature affects the productivity of the lake for different uses. We will need to know if the decrease in coliform bacteria will improve the value of the stream for different uses. We will need to know how the increase in dry season flows will affect uses of the stream and lake. If any of these effects will increase use of the creek and lake for recreation, then the influence should already have been taken into account. If other uses of the water are affected, we will need to know what they are and how the change affects them.

The information might be used as presented in a conceptual discussion of the project. Suppose the project has a benefit/cost ratio of 0.87 and the District Manager wants evidence of additional benefits. These are the kinds of factors that need to be discussed but some of the same questions that need to be raised in a quantitative discussion need to be raised in a conceptual discussion, namely do any benefits flow to people from these additional influences?

Sediment damages are not discussed in either of these projects. Suppose this were Bear Creek where in a major flood 24,000 cubic yards of sediment were caught. Downstream is Prineville Reservoir, heavily used for irrigation water supply and recreation. If the sediment trapped represents the difference in net delivery to the reservoir, then the question is how much damage do 24,000 yards of sediment do to the reservoir? If the reservoir is ultimately to be dredged, then the estimated cost of dredging, discounted for the number of years in the future the event will take place, would represent the benefits of sediment trapping. The U.S. Forest Service has used $5 per ton for the value of silt trapped. The study by Clark found $3 per yard to be a national average cost of dredging.[3]

We need to account for more than one event to estimate a benefit for sediment trapping. We need to relate sediment trapped to different frequencies of storm event and to integrate the distribution function or cumulative frequency curve of sediment trapping to get an annual expected volume of sediment trapped. Suppose the expected annual volume of sediment trapped is 8,000 yards (5 acre feet per year in a 5.5 mile riparian zone) and the average time of dredging is 25 years away; the present value of the

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3. The FS figure of $5/ton is used in"Soil and Water Resource Management: A Cost or a Benefit?", USFS, July, 1987 review draft p. 32. The study by Clark et al. is cited in the references to the main report.

costs per yard is $0.44 and the annual sediment trapping benefit is $3,500 per year. Alternatively, if the cost of lost reservoir capacity is $500 per acre foot, then the annual benefits at this rate are $2,500.[4]

A similar calculation would be used to estimate flood benefits: estimate the flood stage for each frequency event, estimate the damages at each stage and construct the frequency distribution of damages. The expected annual damages avoided are the annual benefits.[5]

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4. Study by Crowder cited in references.

5. These procedures were applied in a Soil Conservation Service/Forest Service study of a watershed in the Cibolla National Forest, New Mexico. (op. cit. pp. 62-64) Annual floodwater and sediment benefits were attributed to a floodwater retardation structure ($21,590), stabilization and sediment control ($945), stabilization of critical areas ($9,930), and contour furrowing-range seeding ($11,030).

Table 1. Burley District Riparian Project Costs

Item	1983	1984	1985	1986	1987	1988	1989	1990
exclosure	3,000							
prescr fire				2,500				
fencing					5,500			
reservoirs					4,000			
pipe + trough						3,500		
burn + seeding								4,600
exclosure	3,000							
pipeline		3,500						
reservoirs			6,000					
well extens.				2,500				
exclosure					4,500			
treat 1000ac						23,000		
fences							1,100	
pipeline							2,500	
exclos.('79)	2,721							
well extens.							1,000	
pipeline							2,500	
Totals	8,721	3,500	6,000	5,000	14,000	26,500	7,100	4,600
Net PV	52,369							
Maint.	2,945							
Total PV	55,314							

Notes:

Costs in 1979 are compounded at 8 pct. to 1983

Net PV discounts all costs to 1983 at 8 pct.

Maintenance costs are PV of $300 per year for 20 years @ 8pct.

Costs do not include ranchers costs.

Table 2. Burley District Riparian Project Benefits

Appendix C

Bibliographic Notes

Bibliographic sources include the BLM riparian bibliographies and a search on DIALOG through the BLM service center library. This search included economics and benefits among the keywords. A rich bibliography exists on riparian protection and management. Less so with economic studies than with physical and biological studies.

Part of this bibliography is reflected in the BLM publication TR 1737-1, 1987 (A Selected, Annotated Bibliography of Riparian Area Management) and part in the bibliography collected by the Idaho state office. Three notable conference proceedings have added immensely to the literature. The First North American Riparian Conference held in Tucson in 1985 and published by the Forest Service as GTR RM-120, the Warner and Hendrix volume, California Riparian Systems, published in 1984, and the proceedings of the Billings conference in May, 1989:Riparian Resource Management, printed by BLM, have each provided wellsprings of information. There were earlier conferences which were important but the later work has by and large been more useful in this study because it reflects progress in our knowledge of riparian relationships. One would also include the essay by Ohmart and Anderson in the BLM volume,Inventory and Monitoring of Wildlife Habitat and the survey of the literature by Skovlin, and related papers published in the NAS/NRC volume, Developing Strategies for Rangeland Management.

The literature reflects a clear evolution in ten years from earlier attempts to publicize and conceptualize problems of riparian areas to more documentation and quantification of the results of management and protection. This evolution is seen in the successive reports from individual investigators. The best examples of progress from observation to prescription are found in the work of Lew Myers and William Platts, each of whom have published in successive conferences but whose papers at the 1989 conference in Billings produced prescriptions for grazing systems based on definitive comparisons of results.

A good example of quantification is found in Shepard's evaluation of the COWFISH model in the volume from Billings. Of 25 papers in the Billings proceedings, fully eight were quantitative field studies. The remainder

reflected preoccupation with the conceptual and motivational.

Work which falls outside the conference volumes but which seems to point toward quantitative resolution of issues includes a series of reports on the Oregon EVAL project, the first by Higgins et al., which has been noted, and the work of the Instream Flow Group at the National Ecology Center, which unaccountably is not prominent in the riparian conference literature.

The riparian and small watersheds literature needs more quantitative economic studies. Numerous studies of the values of wildlife oriented recreation exist, including some excellent studies of instream flow values. Almost no studies serve as models for benefit cost evaluations of riparian projects or of soil and water benefits. The few such studies examined are flawed on the supply side and the demand side. Much more work needs to be done at the interface of economics, biology and hydrology where shaky supply functions and inadequate demand studies now prevail.

Appendix D

Project Chronology

The project commenced March 13, 1989 with preparation of the workplan and initiation of the literature search.

Field visits were initiated March 22 in the Phoenix District, Lower Gila RA, followed by a visit to Safford District, Gila RA March 28-31. Field visits resumed May 22 at the Deseret Land and Cattle Co., Woodruff, UT followed by a seminar and conferences May 24 at Utah State University. Visits continued in the Boise state office May 30-June 2, Vale DO June 6-9, Prineville DO June 12-13, Alturas RA June 15, Lakeview DO June 16, Winnemucca DO June 19 and Elko DO June 20.

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Appendix E

Narrative on the Benefits of Riparian Protection

E.1 Introduction

This narrative is written to comply with objective 5 of the contract statement of work. The purpose of the narrative is to provide a discussion which can be used to popularize the benefits of riparian management. Some of the information comes from the GAO report on riparian management in BLM, and some from the professional literature, but most of it comes from conversations with BLM field staff. The author can document every observation.

E.2 Good riparian management produces benefits for ranchers

Ranchers who are willing to modify their livestock management will improve their production by making better use of riparian areas. Instead of using a riparian pasture all season long they will use it only for short periods when it provides the best forage available on the range. If protected, riparian pastures will have an edge during annual droughts or during the winter dormant season. In cases where the riparian pasture is saved for summer dry period use, livestock are able to maintain condition or continue to gain weight all season by using upland pasture when it is in best condition for grazing and by using riparian pasture when the uplands are unable to provide adequate forage. One rancher supports riparian management because it has reprogrammed the cattle to use the upland forage areas, resulted in increased animal growth and simplified herd management. In cases where the riparian pasture is saved for winter grazing, it can provide an economical substitute for winter feeding of hay. Haymaking and feeding hay in winter are two of the most costly operations in the western livestock industry. Use of riparian pasture in the winter season enables central Oregon ranchers to reduce the daily hay ration from 25 pounds per animal to 5 pounds per animal. One rancher estimates a saving of $10,000 annually in costs of hay from having 350 units of February to April grazing available in riparian pasture.

Under the best of circumstances ranchers can make the switch to better use of riparian areas with no short-term sacrifice in number of grazing units. If the upland pastures and the riparian pastures are severely degraded, then it may be necessary to reduce grazing intensity temporarily to allow forage production to recover. If the livestock operator can afford this temporary reduction, the dividends can be large. The Central Oregon operator who now has 350 units of grazing had to give up 72 units of grazing on the same land for three years. That was 13 years ago. He has

received a 5-fold increase from three years of no grazing and 10 years of careful management.

In the earliest days of grazing the western range there was no winter feeding. For better or worse, the range supported the livestock and wildlife the year around. As the range became depleted and the valley lands were occupied by settlement, haymaking and winter feeding became an established practice in the areas with severe winters. The practice has reached the point that major expenditures are made for irrigation of hayfields and for hay making equipment. One rancher in Utah is making an effort to reduce the costs of haymaking by curtailing irrigation pumping and converting his riparian meadows to winter forage. It is possible that the rediscovery of valley lands and riparian zones as winter forage areas could be a major boon to the livestock industry of the Intermountain West.

E.3 Healthy riparian areas may reduce destruction from flooding and damages from siltation.

Key indicators of health in riparian areas are:

1. good growth of vegetation,
2. stream banks anchored by vegetation and protected from cutting and sloughing,
3. channels which allow high flows to spread over flood plains.

When floods pass through well-anchored riparian areas the water spreads out and slows down, drops much of its load of sediment and does not pick up new sediments from unstable banks. Downstream the flood flow will take a longer time to pass a given point, which means flood depths will be lower and velocities will be less destructive. Fences, buildings, and croplands in the path of the flood will escape with fewer damages and smaller amounts of silt will be deposited in irrigation ditches, on roads and in reservoirs.

In Oregon, recent flood events have illustrated these effects. In the summer of 1978 a severe flood occurred in the Cottonwood Creek watershed in Malheur County. A riparian area protected by BLM caught the brunt of the flood. Immediately downstream a rancher has irrigated hayfields. The rancher believes that without the riparian area his haying operations would have suffered severe damages. In the same county in the Spring of 1984 a similar headwaters flood where there was no riparian protection cost a ranch $60,000 in damages to ditches, fences and fields.

In Crook County, Oregon a flood in June, 1987 caused the loss of 10 to 15 feet of stream bank on either side of the channel on unprotected banks but 5.5 miles of stream protected by BLM suffered no perceptible damage. The stream empties into an irrigation reservoir. The unprotected stream banks contributed large quantities of sediment to the reservoir but BLM estimates

the protected segment of stream trapped 24,000 cubic yards of sediment or enough to fill 14 acres of reservoir with one foot of sediment.

In some instances a lesson in containing floods has been learned the hard way. After repeated attempts to straighten channels and speed the passage of floods, only to have floods become more destructive the farmers on Fifteenmile Creek in central Oregon installed check dams and protected streambanks to encourage revegetation. The destructive force of the floods is now being absorbed in the protected zone and croplands are no longer losing their topsoil. Near Elko, Nevada a rancher straightened a stream channel through a meadow and removed willows only to experience severe downcutting of the channel, loss of his water table and destruction of the productivity of the meadow.

E.4 Good riparian management may improve the flow of water.

Streams that lose their riparian zone may lose the capacity to flow during the dry season because banks which formerly could store water in high flows and release it back to the stream during low flows have no water in storage. Beaver ponds and man made retention dams contribute to this effect. These services are valuable because they provide dry season flows for stock water and, when quantities are sufficient, for irrigation and village water supplies. Restored riparian zones with banks which store water can produce increased dry season flows. Studies by BLM of restored flows in Camp Creek, Oregon will contribute to an understanding of the conditions under which streamflows can be enhanced by better riparian management.

In Muddy Creek, Wyoming check dams and protection of banks has resulted in 400 to 600 acre feet of groundwater storage in the stream banks for natural release during low flows or for withdrawal by pumping.

In Mahogany Creek, Nevada after 10 years of riparian recovery stream flow had increased 400 percent and stream depth had increased 50 percent.

Management of Bonita Creek in Arizona protects the water supply of 17,000 residents who depend on the Safford water utility.

E.5 Good riparian management produces benefits for recreational users.

In restored riparian areas below protected watersheds revegetation restores wildlife habitat, shades and nourishes the stream, and allows fish to return to the stream. Bonita Creek, Arizona supports 58 mammal, 107 bird, 55 reptile, 9 amphibian, and 5 native fish species. Public access and picnic facilities make it attractive for birdwatching and wildlife viewing. Riparian projects in the Burley district, Idaho are expected to increase fishing and hunting by 300 days per year, other types of

recreation by 100 days per year and at the same time add 280 units of available livestock forage. Shoshone district, Idaho expects a fourfold increase in nesting birds, insects, amphibians and small mammals and an added 1500 days of fishing on its 8.9 mile Thorn Creek riparian demonstration project.

E.6 Restoration of riparian areas meets the demands of those who want to bequeath improved public lands to the next generation.

Americans have revised their attitudes toward the public lands. Early American explorers brought back to the East the impression that the west was a desert wasteland. Until well into this century the attitude toward the public domain was that it should be settled and converted to private lands and that the timber and forage on any land that wasn't private property was fair game for any taker. Successive failures at settlement, and obvious degradation of any land that was unowned and unprotected led to the passage of the Taylor Grazing Act in the 1930s and acceptance by the federal government of custodianship of the public domain. After WWII the boom in outdoor recreation and environmentalism elevated wilderness, wildland sports and wildlife appreciation to new popularity. Now the predominant attitude among the American people is one of appreciation of the public lands as environmental amenities. There is reflected in the Federal Land Policy and Management Act of 1976 a desire to retain public lands so people may enjoy them, and know they are in good condition. The nation also wants to preserve and restore the public lands so they may be passed to successive generations as part of our national wealth.

E.7 Riparian protection is achieved through cooperation

Successful riparian restoration is being achieved through cooperative efforts of federal land managers, livestock permittees and representatives of non-profit environmental interests. In exchange for assistance in improving livestock management BLM managers are receiving cooperation from the ranchers. Environmental interests are providing assistance through volunteer work efforts and by making certain projects national demonstrations of success.

As successful projects accumulate ranchers see how much more productive riparian zones can be. Sometimes it takes awhile for this to sink in because the range was in a degraded condition 100 years ago; no one living today has seen what it was like before it was overgrazed and everyone assumes small western streams have always looked the way they look today.